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(19)

(11) Publication number: **0 562 237 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **93101368.4**

(51) Int. Cl.5: **A61N 1/368**

(22) Date of filing: **29.01.93**

(30) Priority: **24.03.92 SE 9200907**

(43) Date of publication of application: **29.09.93 Bulletin 93/39**

(84) Designated Contracting States: **DE FR GB IT NL SE**

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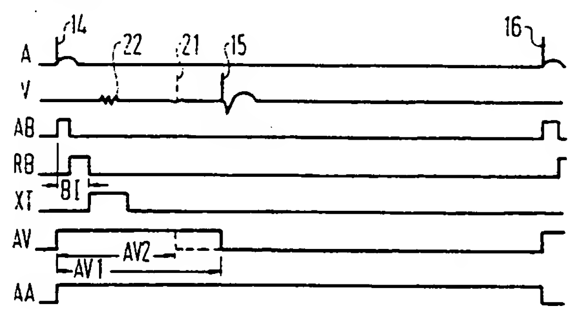
(54) **Dual chamber pacemaker.**

(57) In a dual chamber pacemaker capable of stimulating the atrium and ventricle in a heart, a stimulation pulse (14) in the atrium could be sensed as a ventricular event which cannot be distinguished from a premature ventricular contraction (PVC), so the pacemaker institutes a blanking interval (BI) in which no sensing occurs and a crosstalk interval (XT) in which sensing occurs, detections in the crosstalk interval (XT) causing the emission of a ventricular stimulation pulse with a shortened A-V interval (AV2). In order to optimize the blanking interval (BI) so as to reduce the risk of a PVC being missed at the same time as the number of detected events, caused by crosstalk from the atrium, in crosstalk intervals (XT) is minimized, the pacemaker counts, for a number of cardiac cycles, the number of detections in crosstalk intervals (XT) and relates same to the number of cardiac cycles so as to determine the length of the blanking interval (BI).

FIG 2



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The device relates to a dual chamber pacemaker including a stimulation pulse generator which generates and emits stimulation pulses to an atrium via an arterial electrode lead and to a ventricle via a ventricular electrode lead, a detector which senses events in the ventricle and a control device which controls the stimulation pulse generator and the detector, the control device inhibiting detector sensing, after an atrial stimulation pulse has been emitted, for a preset blanking interval, ordering a ventricular stimulation pulse after a lapse of a preset first A-V interval if no ventricular event is sensed between the end of the blanking interval and the end of the first A-V interval, ordering emission of a ventricular stimulation pulse after a lapse of a preset second A-V interval which is shorter than the first A-V interval if at least one ventricular event is sensed in a preset crosstalk interval after the blanking interval and inhibiting emission of the ventricular stimulation pulse if a ventricular event is sensed after the lapse of the crosstalk interval.

US-A-4,825,870 describes such a dual chamber pacemaker. The prior art pacemaker is capable of stimulating and sensing both in the atrium and ventricle and only stimulates when needed, i.e. when the heart itself is unable to maintain a normal rate. After every atrial event, stimulation or sensed spontaneous contraction, sensing of the ventricle is inhibited for one blanking interval, also referred to as an absolute refractory period, to prevent signals from the atrium from being interpreted as a ventricular contraction through crosstalk picked up by the detector in the ventricle. Numerous sources can give rise to crosstalk, but crosstalk from atrial stimulation pulses in particular can cause problems. The blanking interval is followed by a crosstalk interval, also referred to as a relative refractory period, during which ventricular events are sensed. However, it is impossible to determine whether events in the crosstalk interval are caused by noise or by a premature ventricular contraction (PVC). Since the sum selected for the blanking interval plus the crosstalk interval is selected to be less than the natural atrium-to-ventricle conduction time, i.e. the A-V interval, events in the crosstalk interval are interpreted as noise or crosstalk. But as a safety measure for instances in which a PVC occurs in the crosstalk interval, the A-V interval programmed in the pacemaker is shortened. This is to prevent stimulation during the ventricle's vulnerable phase in conjunction with repolarization of cardiac tissue. In any event, the ventricular stimulation pulse is inhibited if a ventricular event occurs between the end of the crosstalk interval and the end of the programmed, or shortened, A-V interval.

One problem concerns deciding on the length of the blanking interval. The blanking interval should preferably be long enough to permit interference from the atrial stimulation pulse to abate. But if it is too long, there is a risk that a PVC might not be detected, and a ventricular stimulation pulse could be emitted during the vulnerable phase, leading at worst to the triggering of fibrillation. On the other hand, a blanking interval which is too short often leads to detection of noise in the crosstalk interval. Ventricular stimulation with a shortened A-V interval could accordingly occur more frequently. As a result of the shorter A-V interval, a natural ventricular contraction might not have time to occur before the stimulation pulse is emitted. So unnecessary stimulation could occur, causing a needless energy drain on the implantable pacemaker's battery.

US-A-4,974,589 describes a pacemaker in which the blanking interval can be initiated on multiple occasions during one and the same cardiac cycle. A first blanking interval is instituted after an atrial stimulation pulse, and a first crosstalk interval follows at the end of that blanking interval. If an event is detected within a given part of the first crosstalk interval, a second blanking interval is commenced. A second crosstalk interval starts thereafter, and a third blanking interval starts if an event is sensed within that given period. This sequence of blanking and crosstalk intervals continues until no event is sensed in the given part of the respective crosstalk interval, whereupon the crosstalk interval continues in the same way as in the prior art pacemaker described above or until a maximum period of time elapses for blanking and crosstalk intervals, all subsequent events then being interpreted as ventricular contractions.

Even if this solution does produce immediate adaptation of the blanking interval, it does not fully solve the problem of minimizing the duration of the blanking interval without emission of excessive numbers of ventricular stimulation pulses with shortened A-V intervals. In addition, a PVC could appear in one of the crosstalk or blanking intervals without being registered as anything other than noise.

The object of the present invention is to provide a dual chamber pacemaker which automatically sets an optimum blanking interval to minimize the risk of a PVC not being sensed, without any increase in the number of unnecessary stimulations with shortened A-V intervals.

One such dual chamber pacemaker is obtained in accordance with the invention when the control device in the dual chamber pacemaker as described in the preamble relates, for a number of cardiac cycles, the number of detections by the detector in the crosstalk interval to the number of cardiac cycles and orders a change in the blanking interval on the basis of the relationship obtained,

whereby the blanking interval is increased if the obtained relationship exceeds a preset relationship value and is reduced if the obtained relationship is less than the preset relationship value.

In this manner, the pacemaker automatically determines the blanking interval by relating the number of detections sensed by the detector in crosstalk intervals to the number of cardiac cycles, comparing the relationship obtained with a preset relationship value and then modifying the blanking interval. The length of the blanking interval can therefore be optimized to minimize the risk of a PVC appearing without being detected, with no increase in the number of detections, caused by atrial stimulation pulses, in the crosstalk interval. The change in the blanking interval can be made in specific steps or determined on the basis of the comparison. The preset relationship value could be e.g. 3 detections for every 50 cardiac cycles, but it can also be set as a range, e.g. 2 to 4 detections for every 50 cardiac cycles, the blanking interval then being reduced if fewer than 2 detections are sensed and increased if more than 4 detections are sensed.

It is advantageous if the sum of the blanking interval and the crosstalk interval is constant. A total duration for these two parameters can be chosen which approximately corresponds to the spontaneous A-V conduction time, minimizing the risk of a normally conducted ventricular event being detected in the crosstalk interval when the blanking interval has been increased.

In another embodiment of the dual chamber pacemaker according to the invention, the control device counts, for a given number of cardiac cycles, the number of detections in crosstalk intervals. The blanking interval is then increased when the number of detections exceeds a preset value, and the blanking interval is decreased when the number of detections is less than the preset value.

With a given number of cardiac cycles, the relationship is only dependent on the number of detections. The number of detections can then be allowed to govern the way in which the blanking interval is modified. An appropriate number of cardiac cycles could be 60 to 100.

Instead of having the device count the number of detections in a given number of cardiac cycles, the number of cardiac cycles could be limited to a maximum figure, the control device then comparing the number of detections in crosstalk intervals with a preset value after each cardiac cycle and increasing the blanking interval if the number of detections exceeds that preset value.

In this manner, there is no need to increase the blanking interval after a specific number of cardiac cycles. Instead, the blanking interval is increased as soon as conditions for increasing the blanking interval arise. This reduces the risk of unnecessary detections in crosstalk intervals. The maximum number of cardiac cycles could e.g. be 100. A value for the preset figure can be obtained from the preset relationship value. e.g. 3 detections in every 50 cardiac cycles as noted above. recalculated for 100 cardiac cycles, i.e. 6 detections. So if 7 detections have been registered after the fiftieth cardiac cycle, the blanking interval clearly must be increased. Instead of continuing to count another 50 cardiac cycles before the blanking interval is increased, the system institutes the increase after the first 50 cardiac cycles.

Alternately, evaluation can be performed in such a way that the control device counts the number of cardiac cycles between two successive detections in crosstalk intervals, the blanking interval is increased when the number of cardiac cycles is less than a preset value and decreased when the number of cardiac cycles exceeds the preset value, and the control device includes a means for limiting the time during which the number of cardiac cycles ic counted.

Thus, the number of cardiac cycles can be used as a parameter governing the way in which the blanking interval is modified. The ability to limit the time spent on counting is necessary in case a large number of cardiac cycles are counted before the second detection occurs. The limitation could e.g. be imposed by setting an upper limit for the number of cardiac cycles to be counted. It would be advantageous here if the means for limiting cardiac cycle counting after each cardiac cycle compared the number of cardiac cycles with the preset value, and if the number exceeds the preset value the blanking interval is decreased and the counting terminated.

It would be an advantage for the alternative embodiment above if evaluation only took into account cardiac cycles in which atrial stimulation occurred. This would lead to more accurate control of existing crosstalk. In this instance, the preset relationship value would be more relevant, since it is directly related to the instances in which crosstalk from stimulation impulses in the atrium could occur.

An advantageous improvement of the dual chamber pacemaker is obtained in accordance with the invention if the control device orders a relative blanking interval constituting a part of the blanking interval, the detector senses ventricular events in the relative blanking intervals, the control device relates the number of detections in the relative blanking intervals to the number of cardiac cycles and the control device determines a change in the blanking interval on the basis of the obtained relationships in such a way that the blanking interval is increased if the relationship between the number of

detections in the crosstalk intervals and the number of cardiac cycles exceeds the preset relationship value or if the relationship between the number of detections in the relative blanking intervals and the number of cardiac cycles exceeds a second preset relationship value, and that the blanking interval is decreased if the relationship between the number of detections in the crosstalk intervals and the number of cardiac cycles is less than the preset relationship value at the same time as the relationship between the number of detections in the relative blanking intervals and the number of cardiac cycles is less than the preset relationship value.

The blanking interval is subdivided in such a way that sensing takes place during part of the interval without the pacemaker regarding it as a ventricular event, i.e. no stimulation pulse is emitted after a shortened A-V interval. As a result, the tolerance level for detections in the crosstalk interval can be reduced and the length of the blanking interval optimized further. The degree of tolerance to detections in the relative blanking interval can be set relatively high, since they do not cause stimulation with a shortened A-V interval. The relationship 1, i.e. 1 detection in the relative blanking interval for each cardiac cycle, is conceivable in extreme cases. If the length of the blanking interval is not adjusted consecutively, i.e. if there is no new counting of cardiac cycles and detections immediately after the preceding count, setting the degree of tolerance lower than 1 may be an advantage, e.g. as a range of 40 to 80 detections for every 100 cardiac cycles. This is because a minor physiological change in the heart could cause an increase in the duration of noise, thereby leading to a rapid rise in the number of crosstalk in the crosstalk interval, if a long time elapses with a blanking interval minimized to such an extreme degree that every atrial stimulation pulse causes detection in the relative blanking interval.

The relative blanking interval should mainly be constant and set by a physician with a programming unit capable of communicating with the pacemaker. Similarly to what has been described above, detections in the relative blanking interval can also be used to reduce the number of cardiac cycles required to institute a change in the blanking interval.

As already noted, the counting of heart cycles and detections can be consecutive or at intervals. Consecutive counting is performed in such a way that a new count starts as soon as a relationship has been established and compared to the preset relationship value to determine the change in the blanking interval. Counting made at certain intervals can then be initiated by e.g. changes in amplitude and duration of the atrial stimulation pulse.

The invention is described in greater detail below, with reference to three figures, whereby:

Figure 1
shows a block diagram of an embodiment of a dual chamber pacemaker in accordance with the invention,

Figure 2
shows a diagram of a cardiac cycle, describing the operation of the embodiment according to figure 1, and

Figures 3a, 3b
show a flowchart which exemplify one way which the embodiment may perform an evaluation in accordance with the invention.

Figure 1 shows a block diagram of a dual chamber pacemaker 1 as one embodiment according to the invention. The dual chamber pacemaker 1 comprises an atrial stimulation pulse generator 2 , an atrial detector 3, a ventricular stimulation pulse generator 10, a ventricular detector 11, a control device 4 and a telemetry unit 12. The atrial stimulation pulse generator 2 generates stimulation pulses which are delivered to the atrium in the heart 5 via an atrial electrode lead 6 and atrial electrode tip 7. The ventricular stimulation pulse generator 10 generates stimulation pulses which are delivered to the ventricle in the heart 5 via a ventricular electrode lead 8 and a ventricular electrode tip 9. The pacemaker 1 can detect events, spontaneous or stimulated, in the heart 5 by sensing electrical activity. Electrical signals in the atrium are picked up by the atrial electrode tip 7 and transmitted to the atrial detector 3 via the atrial electrode lead 6. Electrical signals in the ventricle are picked up by the ventricular electrode tip 9 and transmitted to the ventricular detector 11 via the ventricular electrode lead 8. The detectors 3, 11 analyze the electrical signals to determine whether or not they constitute a cardiac event and send analysis results to the control device 4. The control device 4 controls the sensitivity of the detectors 3, 11 and also governs the periods of time in which the detectors 3, 11 are active. On the basis of detected events, or the absence of such events, the control device 4 controls the emission of stimulation pulses by the stimulation pulse generators 2, 10. It also controls the amplitude, duration and emission rate of atrial and ventricular stimulation pulses. A physician, using an external programming unit 13, can check and change settings in the pacemaker 1. Communications between the control device 4 and the programming unit 13 are transmitted via the telemetry unit 12.

The pacemaker 1 operates with an inhibiting function which ensures that no stimulation pulses are emitted as long as the heart 5 functions spontaneously with an adequate pulse rate. The rate can be checked and controlled in different ways, e.g.

by checking and controlling the time elapsing between two consecutive atrial stimulations (A-A control) or by checking and controlling the time elapsing between a ventricular event and the subsequent atrial stimulation (V-A control). The ventricle is stimulated if no spontaneous event occurs within a given period of time after an atrial event (the A-V interval).

FIG. 2 illustrates the function of the pacemaker 1. When a stimulation pulse 14 is delivered to the atria, there is a risk of this electrical activity being detected in the ventricle and interpreted as a premature ventricular contraction (PVC). To prevent this, the control device 4 inhibits the ventricular detector's 11 sensing for an absolute blanking interval AB which constitutes part of a blanking interval BI after the emitted atrial stimulation pulse 14. A relative blanking interval RB, during which the ventricular detector 11 is active and senses activity in the ventricle, also occurs in the blanking interval BI. However, events sensed in the relative blanking interval RB are ignored by the control device 4 and only serve as input for optimizing the duration of the blanking interval BI as described in greater detail below. A crosstalk interval XT follows the blanking interval BI. Events occurring in this interval may be caused by noise from atrial stimulation or by a PVC. If an event 22 is sensed in this interval, the programmed A-V interval AV1 is shortened to a shortened A-V interval AV2 (dashed line), and a ventricular stimulation pulse 21 is emitted after the shortened A-V interval AV2 has expired. As it cannot be determined whether or not the event is due to a PVC, the stimulation pulse 21 is emitted as an additional safety precaution to maintain the heart's pumping function. The A-V interval AV1 is shortened to prevent stimulation in the vulnerable phase following a ventricular contraction if a PVC should be the cause of the detection. If no event occurs in the crosstalk interval XT or the remaining part of the A-V interval AV1, a ventricular stimulation pulse 15 is emitted. The pacemaker then waits for the A-A interval to end before the next atrial stimulation pulse 16 has to be emitted.

If a spontaneous ventricular event occurs after the crosstalk interval XT elapses, but before the A-V interval AV1, AV2 elapses, the control device 4 inhibits emission of the ventricular stimulation pulse.

FIG. 3a and 3b show a flowchart describing a function which can be performed by the pacemaker 1 in FIG. 1 for minimizing the blanking interval BI. The flowchart only shows the steps essential to function. In the following example, the relative blanking interval RB is constant, and the change in the blanking interval BI is made by modifying the absolute blanking interval AB. In the start block, FIG. 3a, the number of accumulated cardiac cycles n, the number of events detected in the relative blanking interval VRB and the number of events detected in the crosstalk interval VXT are zeroed. In addition, the current A-V interval AV is set at interval duration AV1 which corresponds to the programmed A-V interval.

In the next function block (DET A?), the atrium is sensed for spontaneous events. If a spontaneous event occurs, emission of an atrial stimulation pulse (INHIBIT A) is inhibited at the same time as the A-V and A-A intervals are started. Since crosstalk to the ventricle occurs after stimulation in the atrium, cardiac cycles with spontaneous atrial heart beats are not included in the evaluation. In this branch of the flowchart the ventricle is only sensed for spontaneous events (DET V?) until the A-V interval expires (END AV?). The ventricle (STIM V) is stimulated if no spontaneous event has been sensed , and the atrial sensing block then awaits the next cardiac cycle. If a spontaneous event is detected, emission of the ventricular stimulation pulse (INHIBIT V) is inhibited, and the next cardiac cycle is awaited.

If no spontaneous atrial event is sensed before the A-A interval expires (exit YES in block END AA?), the atrium is stimulated (STIM A), the number of accumulated cardiac cycles is increased by an increment of 1 (n = n + 1) and the AA, AV and AB intervals are started. There is no sensing during the absolute blanking interval AB, and this interval elapses without any other functional operations. The relative blanking interval RB (START RB) is started after the lapse of the absolute blanking interval AB. The ventricle is sensed (DET V?) during this interval. As long as no event is detected the interval passes with alternative checks on events and interval time. If no event is sensed before the relative blanking interval RB expires, the crosstalk interval XT (START XT) starts. If an event is detected the number of events VRB sensed in the relative blanking interval RB is increased by an increment of 1 (VRB = VRB + 1), the end of the interval then being awaited and the crosstalk interval XT starting thereafter. Evaluation only allows one registered event in the relative blanking interval RB for each cardiac cycle.

The flowchart continues with the crosstalk interval XT, FIG. 3b. If no event is detected, expiration of the interval is awaited. If an event is detected, the number of detected events VXT in the crosstalk interval is increased by an increment of 1 (VXT = VXT + 1) at the same time as the A-V interval AV is set at the shortened interval duration (AV = AV2) .

After the crosstalk interval XT , the ventricle (DET V?) is sensed for the rest of the A-V interval (END AV?). If no event is detected before the A-V interval AV elapses, a ventricular stimulation pulse

(STIM V) is emitted. If an event is detected emission of the stimulation pulse is inhibited (INHIBIT V).

When the A-V interval expires, a check is also made as to whether the number of accumulated cardiac cycles n has reached the number of cardiac cycles N to be covered by the evaluation. If this is not the case (exit NO in block n = N?), a check is made as to whether the number of sensed events VXT in the crosstalk interval XT has exceeded a preset permissible number of events VN for the entire evaluation (VXT > VN?). If this is the case, the evaluation does not need to run through the remaining cardiac cycles. The absolute blanking interval can be increased immediately (INCREASE AB) , and evaluation ends (END). Otherwise, the next cardiac cycle is awaited.

Results are evaluated when the prescribed number of cardiac cycles N is reached. The number of events VRB in the relative blanking interval RB is compared to a preset number VM (VRB > VM?), and the number of events VXT in the crosstalk interval is compared to the preset number of permissible events VN (VXT > VN?).

If the number of events VRB in the relative blanking interval RB is greater than the preset number VM, or if the number of events VXT in the crosstalk interval XT is greater than the preset permissible number VN (exit YES block VXT > VN?; VRB > VM?), the absolute blanking interval AB is increased (INCREASE AB) and the evaluation ends (END). Otherwise, a check is made to determine whether the number of events VRB in the relative blanking interval RB is less than the preset number VM (VRB < VM?). If this is the case, the absolute blanking interval AB (DECREASE AB) is decreased and the evaluation ends (END). If the number of events VRB in the relative blanking interval RB is equal to the preset number VM, no change is made in the absolute blanking interval AB, and the evaluation ends (END).

Increases or decreases in the absolute blanking interval AB can be made in preset steps or decided in each evaluation. Evaluation can also be performed on a number of consecutive cardiac cycles with no consideration paid to whether or not an atrial stimulation pulse is emitted. The preset number VM and the preset permissible number VN can consist of intervals in which the number of detections VXT, VRB must exceed the upper interval limit for the absolute blanking interval AB to be increased and less than the lower interval limit for the absolute blanking interval AB to be decreased. No check is necessary during the acquisition of evaluation data, but since an attempt is made to minimize the number of these sensed events by changing the length of the blanking interval BI, continuous checks would be an advantage. This is for the same reason why the relative blanking interval RB was introduced, since events sensed in this interval are only used for the evaluation, so the blanking interval BI can be optimized without too many detections in the crosstalk interval XT. Also the number of detections VRB in the relative blanking interval RB could be checked in the corresponding manner after each cardiac cycle n.

There are many other suitable ways of performing the evaluation, e.g. by counting the number of cardiac cycles between two consecutive, sensed events in the crosstalk interval XT. The function may also for this kind of evaluation be designed so only cardiac cycles with atrial stimulation are taken into account.

Claims

1. Dual chamber pacemaker (1) including a stimulation pulse generator (2, 10) which generates and emits stimulation pulses to an atrium via an atrial electrode lead (6) and to a ventricle via a ventricular electrode lead (8), a detector (11) which senses events in the ventricle and a control device (4) which controls the stimulation pulse generator (2, 10) and the detector (11), the control device (4) inhibiting detector (11) sensing, after an atrial stimulation pulse has been emitted, for a preset blanking interval (BI), ordering emission of a ventricular stimulation pulse after a lapse of a preset first A-V interval (AV1) if no ventricular event is sensed between the end of the blanking interval (BI) and the end of the first A-V interval (AV1), ordering emission of a ventricular stimulation pulse after a lapse of a preset second A-V interval (AV2) which is shorter than the first A-V interval (AV1) if at least one ventricular event is sensed in a preset crosstalk interval (XT) after the blanking interval (BI) and inhibiting emission of the ventricular stimulation pulse if a ventricular event is sensed after the lapse of the crosstalk interval (XT), **characterized in** that the control device (4), for a number of cardiac cycles (N), relates the number of detections (VXT) by the detector (11) in the crosstalk interval (XT) to the number of cardiac cycles (N) and orders a change in the blanking interval (BI) on the basis of the relationship obtained, whereby the blanking interval (BI) is increased if the obtained relationship exceeds a preset relationship value and reduced if the obtained relationship is less than the preset relationship value.

2. A dual chamber pacemaker as claimed in claim 1, wherein the sum of the blanking interval (BI) and the crosstalk interval (XT) is con-

stant.

3. A dual chamber pacemaker as claimed in claim 1 or 2, wherein the control device (4), for a preset number of cardiac cycles (N), counts the number of detections (VXT) in the crosstalk intervals (XT), and the blanking interval (BI) is increased if the number of detections exceeds a preset value (VN) and decreased if the number of detections (VXT) is less than the preset value (VN).

4. A dual chamber pacemaker as claimed in claim 1 or 2, wherein the number of cardiac cycles during which detections are counted is limited to a maximum number, the control device (4) compares after every cardiac cycle the number of detections (VXT) in the crosstalk interval (XT) with a preset value (VN), and the blanking interval (BI) is increased if the number of detections (XVT) exceeds the preset value.

5. A dual chamber pacemaker as claimed in claim 1 or 2, wherein the control device (4) counts the number of cardiac cycles between two successive detections in the crosstalk interval (XT), the blanking interval (BI) is increased if the number of cardiac cycles is less than a preset value and decreased if the number of cardiac cycles exceeds the preset value and the control device (4) includes a means for limiting the time during which the number of cardiac cycles is counted.

6. A dual chamber pacemaker as claimed in claim 5, wherein the means for limiting the time during which the number of cardiac cycles is counted after each cardiac cycle compares the number of cardiac cycles with the preset value and the blanking interval (BI) is decreased and the counting ended if the number exceeds the preset value.

7. Dual chamber pacemaker as claimed in any of the above claims, wherein only cardiac cycles during which stimulation of the atrium occurs are taken into account.

8. Dual chamber pacemaker as claimed in any of the above claims, wherein the control device (4) sets a relative blanking interval (RB) which constitutes a part of the blanking interval (BI), the detector (11) senses ventricular events during the relative blanking intervals (RB), the control device (4) relates the number of detections (VRB) in the relative blanking intervals (RB) to the number of cardiac cycles (N) and the control device (4) determines a change in the blanking interval (BI) on the basis of the obtained relationships in such a way that the blanking interval (BI) is increased if the relationship between the number of detections (VXT) in the crosstalk intervals (XT) and the number of cardiac cycles (N) exceeds the preset relationship value or if the relationship between the number of detections (VRB) in the relative blanking intervals (RB) and the number of cardiac cycles (N) exceeds a second preset relationship value and that the blanking interval (BI) is decreased if the relationship between the number of detections (VXT) in the crosstalk intervals (XT) and the number of cardiac cycles (N) is less than the preset relationship value at the same time as the relationship between the number of detections (VRB) in the relative blanking intervals (RB) and the number of cardiac cycles is less than the second preset relationship value.

FIG 1

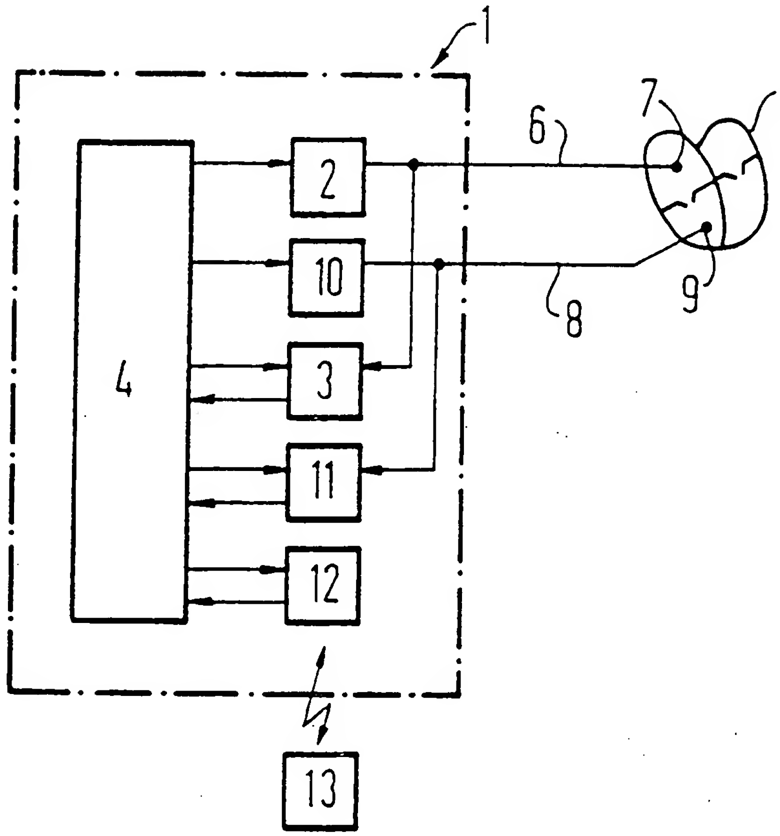


FIG 2

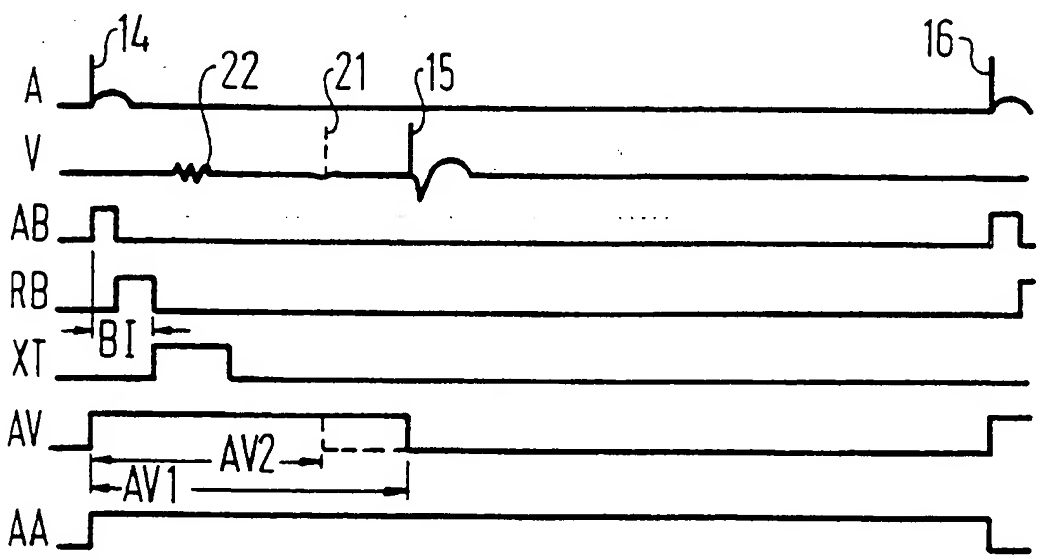


FIG 3a

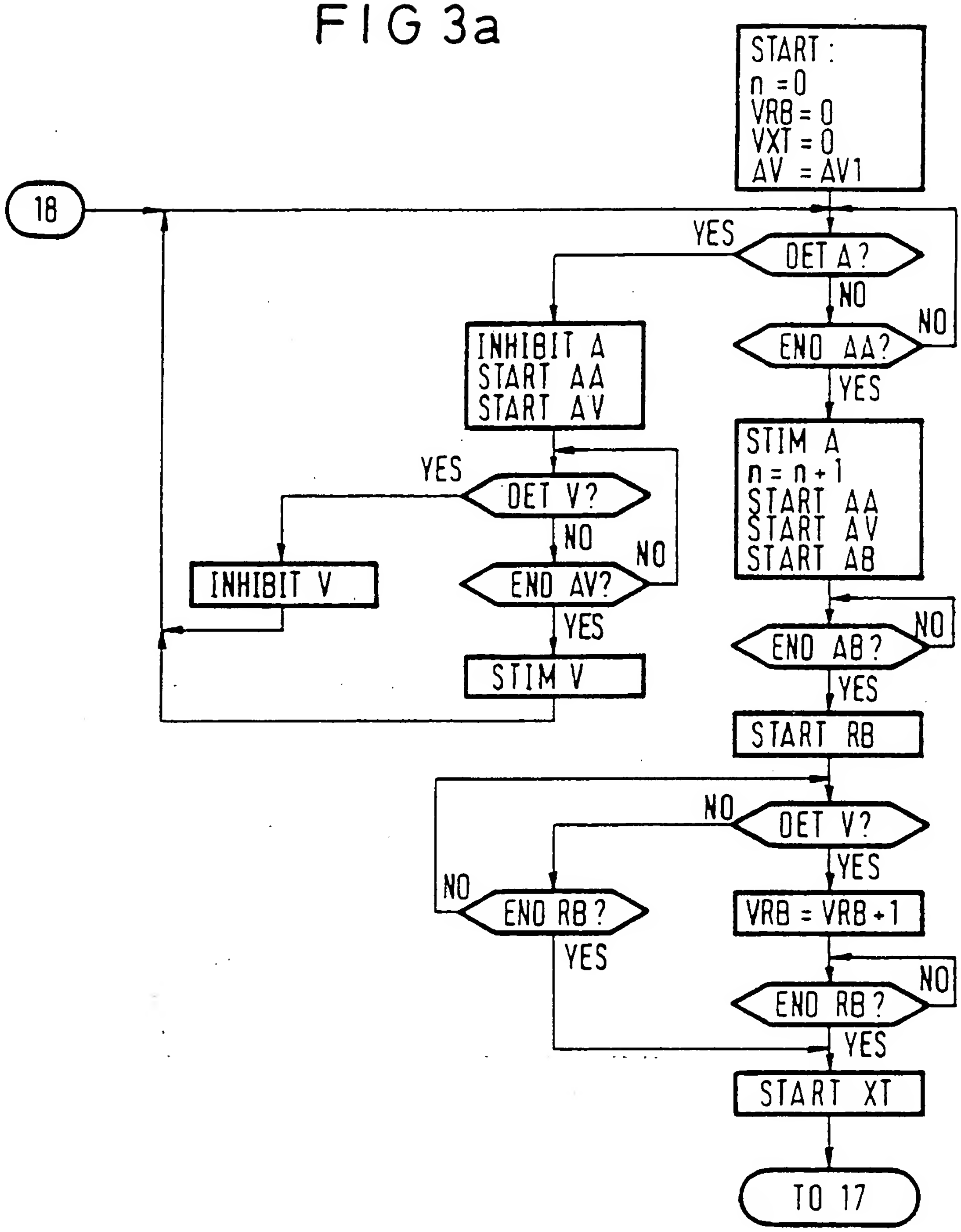
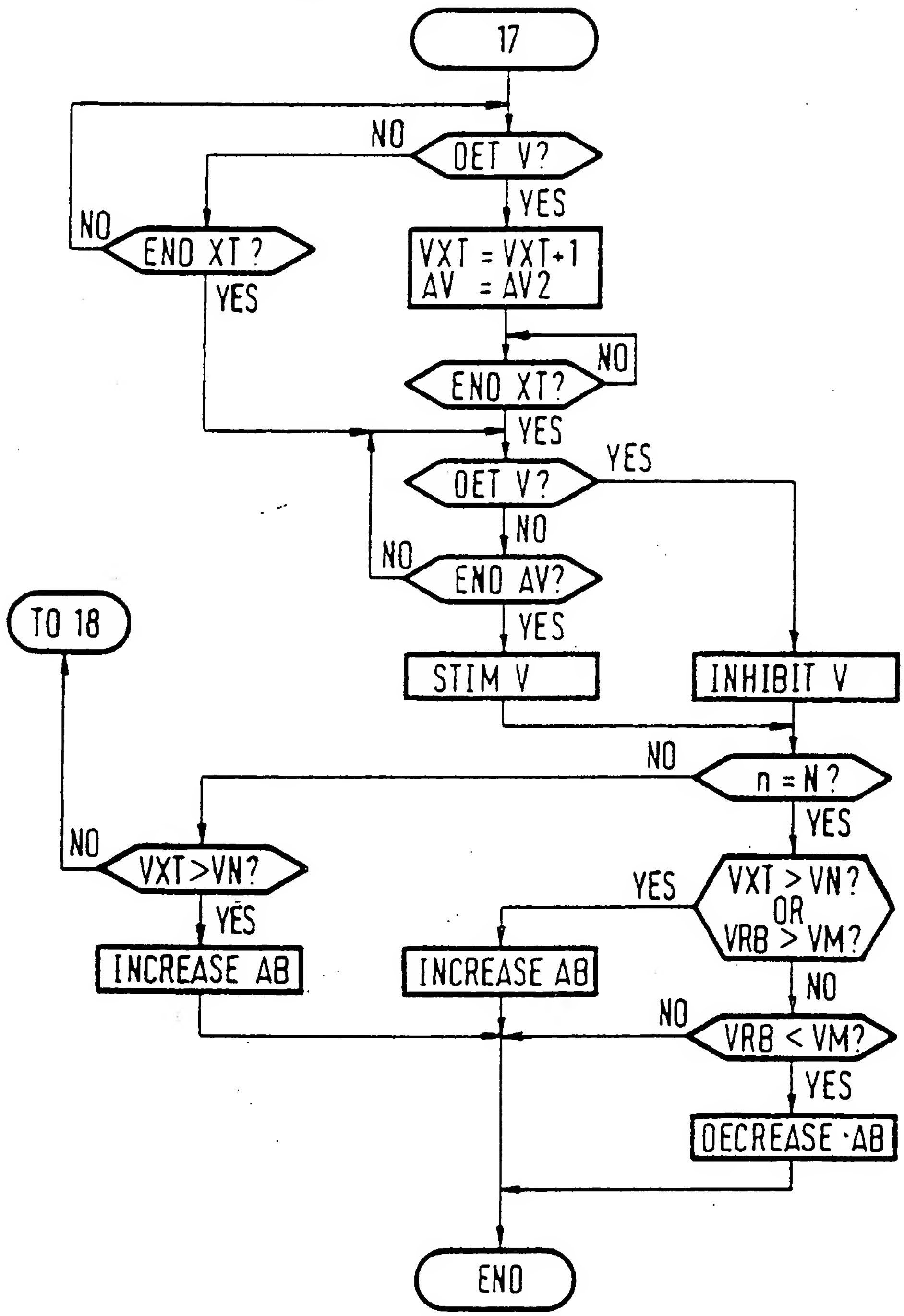

START :
n = 0
VRB = 0
VXT = 0
AV = AV1
18
DET A ?
YES
NO
END AA?
NO
YES
INHIBIT A
START AA
START AV
STIM A
n = n + 1
START AA
START AV
START AB
DET V?
YES
NO
NO
INHIBIT V
END AV?
YES
STIM V
END AB ?
NO
YES
START RB
DET V?
NO
YES
END RB ?
NO
YES
VRB = VRB + 1
END RB ?
NO
YES
START XT
TO 17

FIG 3b


17
DET V?
NO
YES
NO
END XT ?
YES
VXT = VXT+1
AV = AV2
NO
END XT?
YES
YES
DET V?
NO
NO
END AV?
YES
TO 18
STIM V
INHIBIT V
NO
n = N ?
YES
NO
VXT>VN?
YES
YES
VXT > VN?
OR
VRB > VM?
INCREASE AB
INCREASE AB
NO
NO
VRB < VM?
YES
DECREASE AB
END

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93101368.4

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A- 4 825 870 (BRIAN M. MANN ET AL) *figure 3* --	1-8	A61N 1/368
A	US-A- 4 974 589 (JASON A. SHOLDER) *claim 1* --	1-8	
A	EP-A1-0 451 498 (SIEMENS ELEMA AB) *whole document* --	1-8	
A	US-A- 5 027 815 (HERMAN D. FUNKE ET AL) *whole document* --	1-8	
A	US-A- 4 967 746 (JOSEPH W. VANDERGRIFF) *whole document* -------	1-8	TECHNICAL FIELDS SEARCHED (Int. Cl.5) A61N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
STOCKHOLM	08-07-1993	R. BENGTSSON

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document